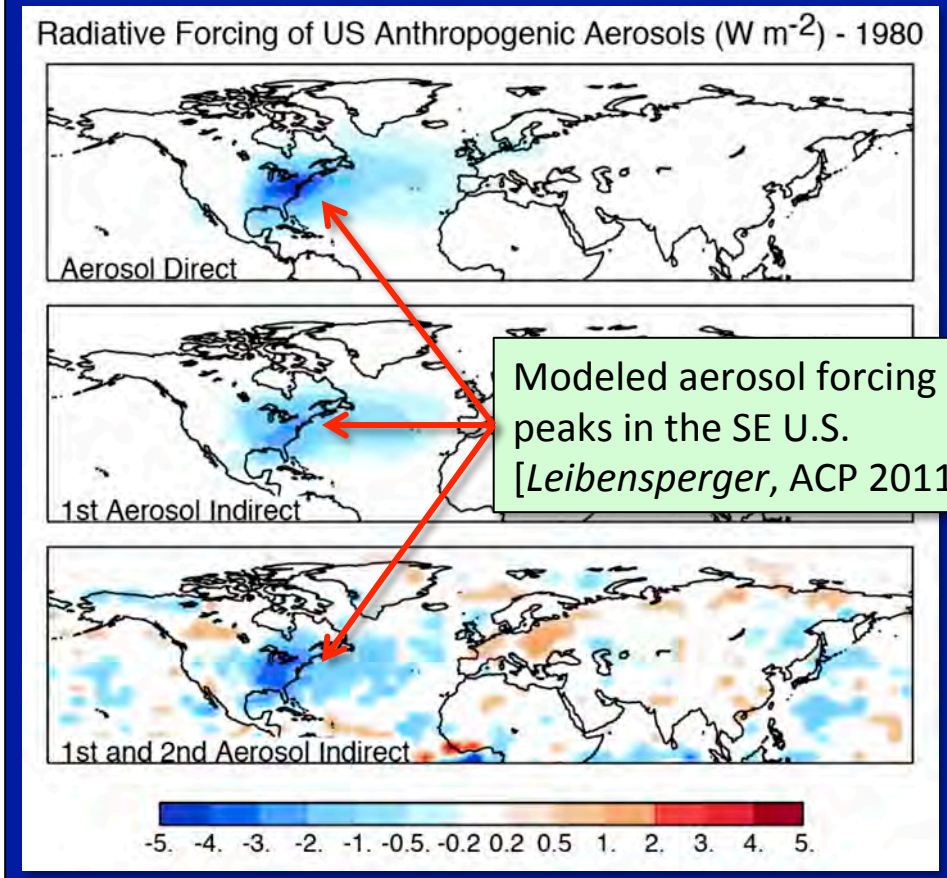
Southeast Nexus (SENEX)

Studying the Interactions Between Natural and Anthropogenic Emissions at the Nexus of Air Quality and Climate Change



Modeled aerosol forcing peaks in the SE U.S. [*Leibensperger*, ACP 2011]

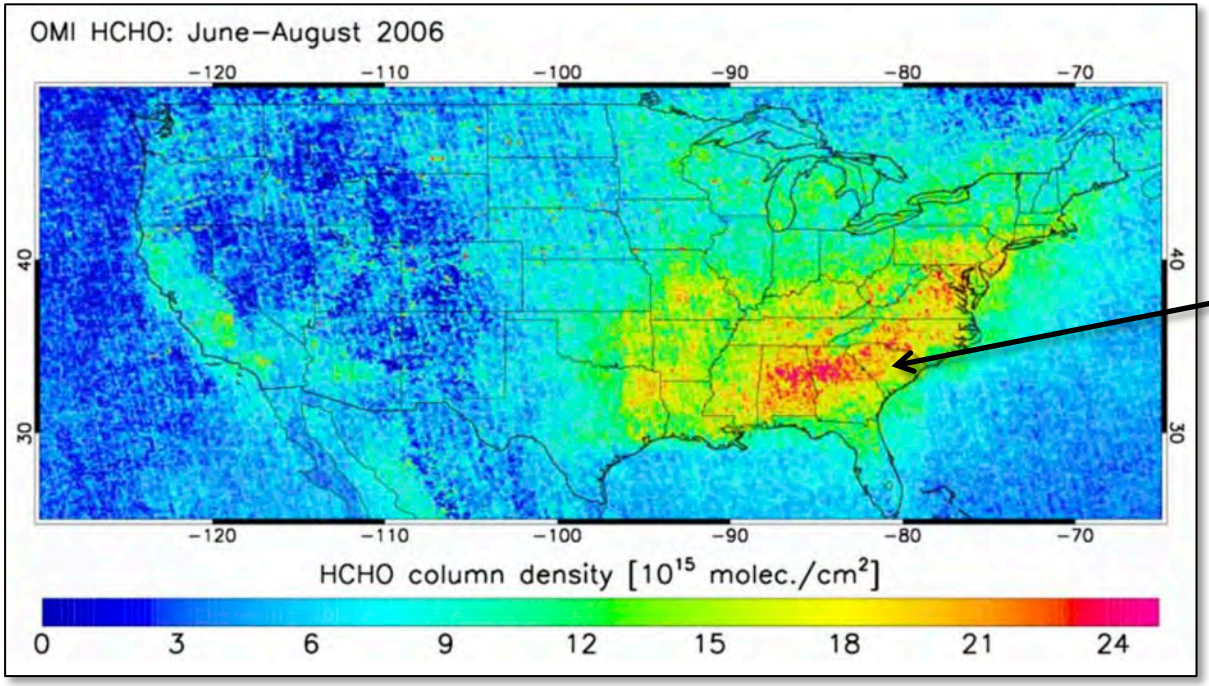
- Southeast U.S. has high anthropogenic and biogenic emissions, humidity, and photochemistry
- How do the emissions react to form aerosol and oxidants?
- What are the climate-relevant properties of the aerosol?

A NOAA Field Study in the Southeast U.S. in Summer 2013

Scientific Motivation

Southeast U.S.:

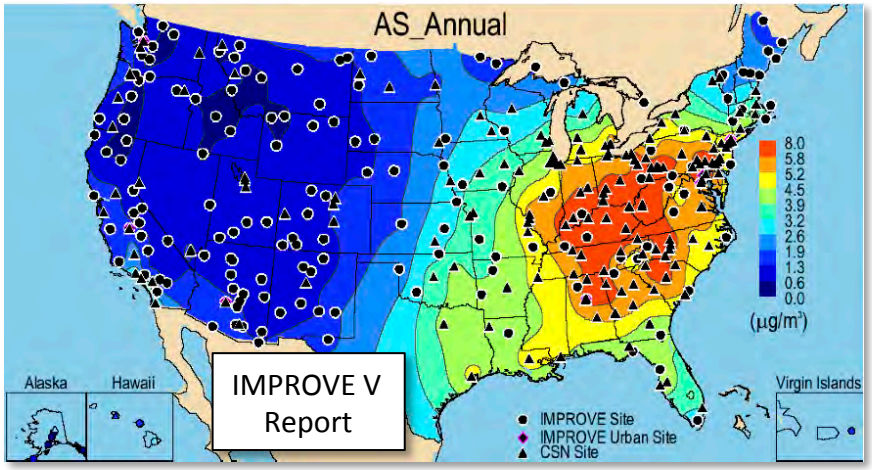
- Many secondary pollutants and radiative forcings are higher than elsewhere in the Nation



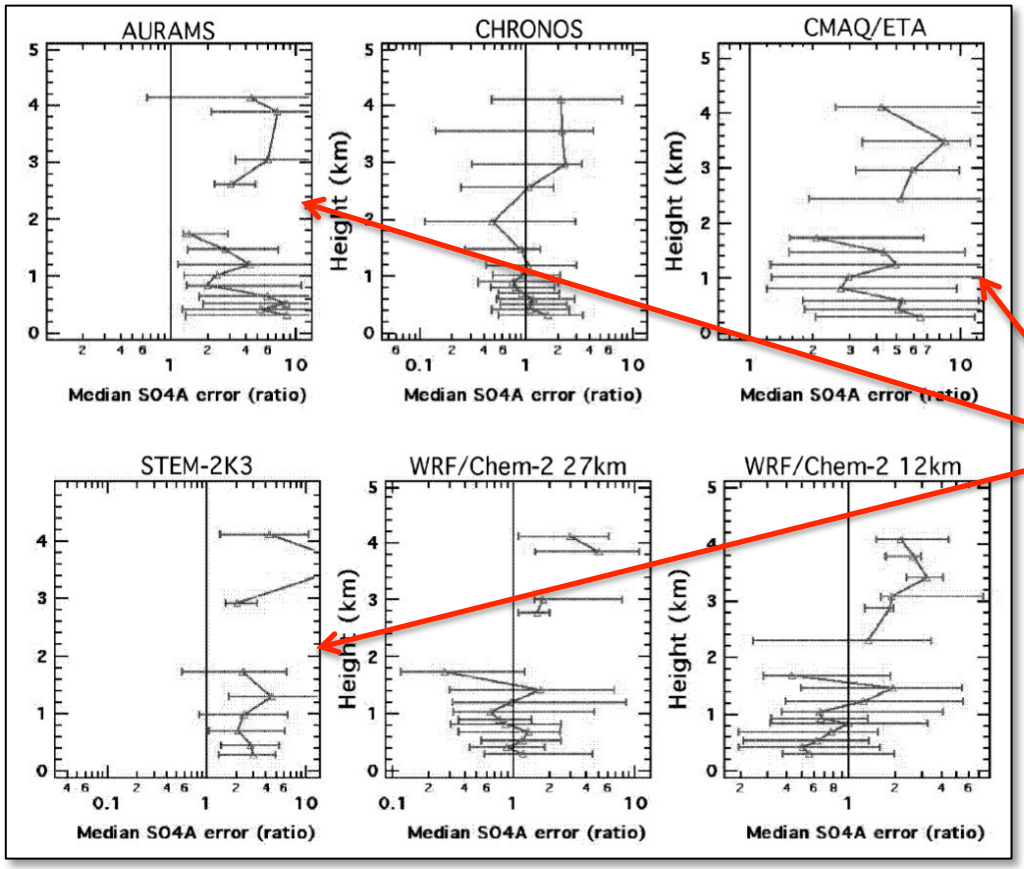
OMI HCHO column peaks in summer SE U.S. [*Millet, 2008*]

How do anthropogenic and biogenic emissions interact and affect air quality and climate?

Sulfate Aerosol

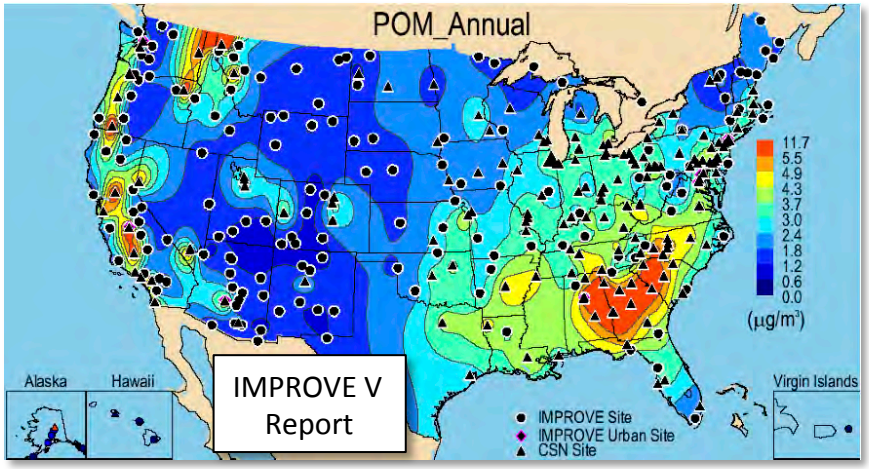


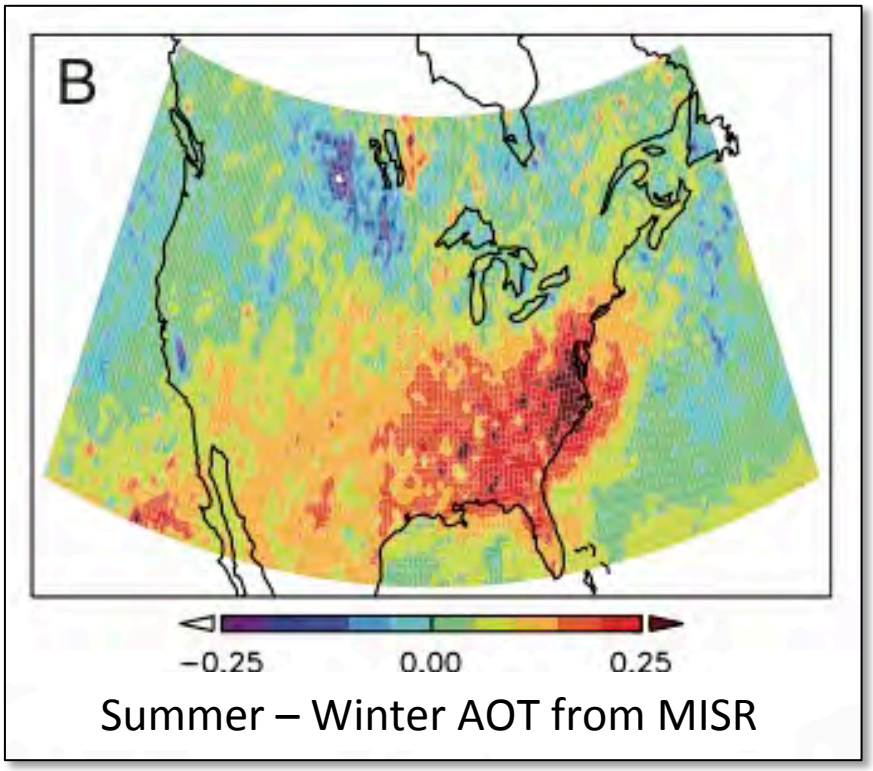
- Sulfate still represents a major fraction of submicron aerosol in the East and Southeast
- Formation in gas phase vs. clouds poorly understood



Models that include cloud oxidation overestimate sulfate [*McKeen*, 2007]

Organic Aerosol



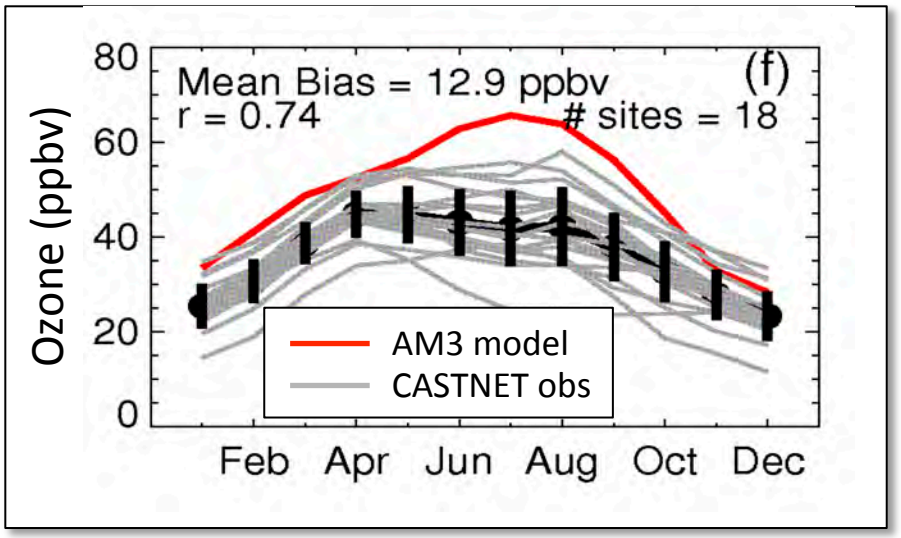


Summer – Winter AOT from MISR

Goldstein [2009]

- Observations show highest organics in Southeast
- Satellite AOT shows strong seasonal cycle: biogenic SOA? (But: IMPROVE shows larger cycle for sulfate)
- Role of aqueous-phase processing?
- Role of nighttime oxidation of biogenic VOCs?
- What fraction of SOA is controllable?

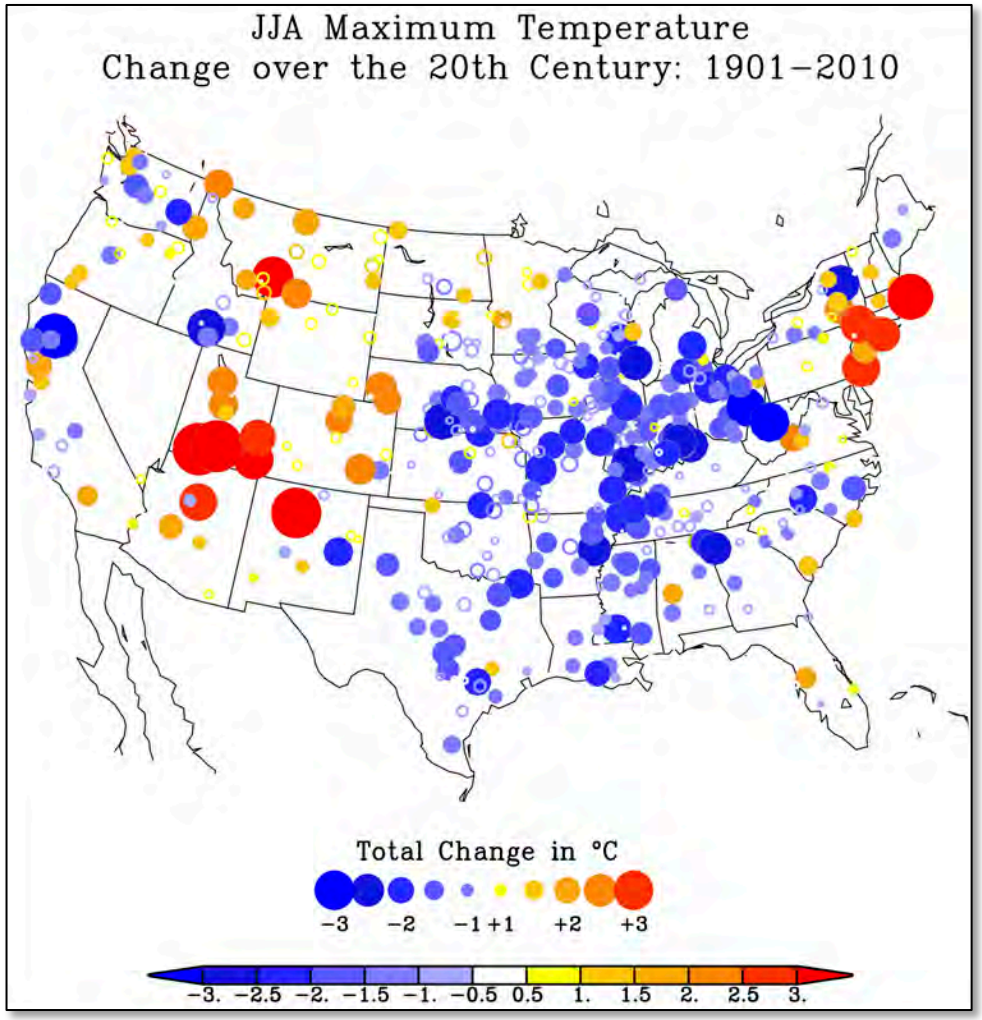
Tropospheric Ozone



Fiore [2009]

- Many models are biased high in the Summertime SE U.S.
- Yield and fate of isoprene nitrates?
- Nighttime chemistry and removal of NO_x?
- Difficulty in modeling the structure of the nighttime boundary layer?

Part of the motivation: Regional Climate Change and its causes



NOAA Science Challenge Workshop [2011]

- Eastern U.S. has not warmed since 1950 and has received more precipitation [*Portmann*, PNAS 2009]
- Connection with aerosol distribution?
- SENEX contribution:
  1. Describe and improve understanding of aerosol distribution
  2. Describe climate-relevant properties of aerosol

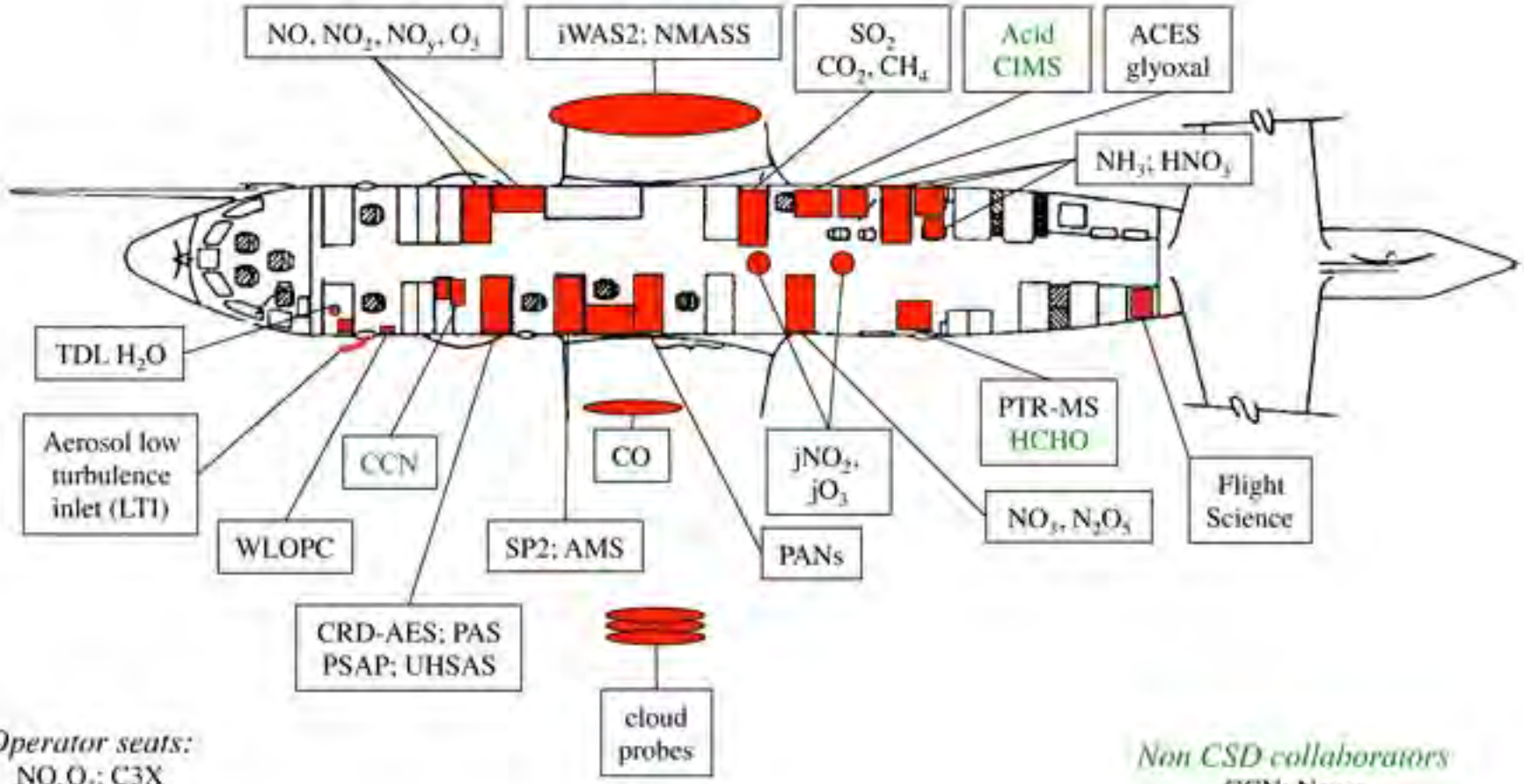
Main Science Questions for SENEX

1. What are the emissions of aerosol, aerosol precursors and greenhouse gases in the SE U.S.?
2. What is the composition and distribution of aerosol in the SE U.S.?
3. What are the formation mechanisms of secondary species (ozone, sulfate and organics) in the SE U.S.?
4. Which deposition processes are critical for determining atmospheric concentrations of aerosol, ozone and NOy?
5. What are the climate-relevant properties of aerosol in the SE U.S.?

More details in White Paper: www.esrl.noaa.gov/csd/projects/senex/whitepaper.pdf

NOAA WP-3D Instrument Payload

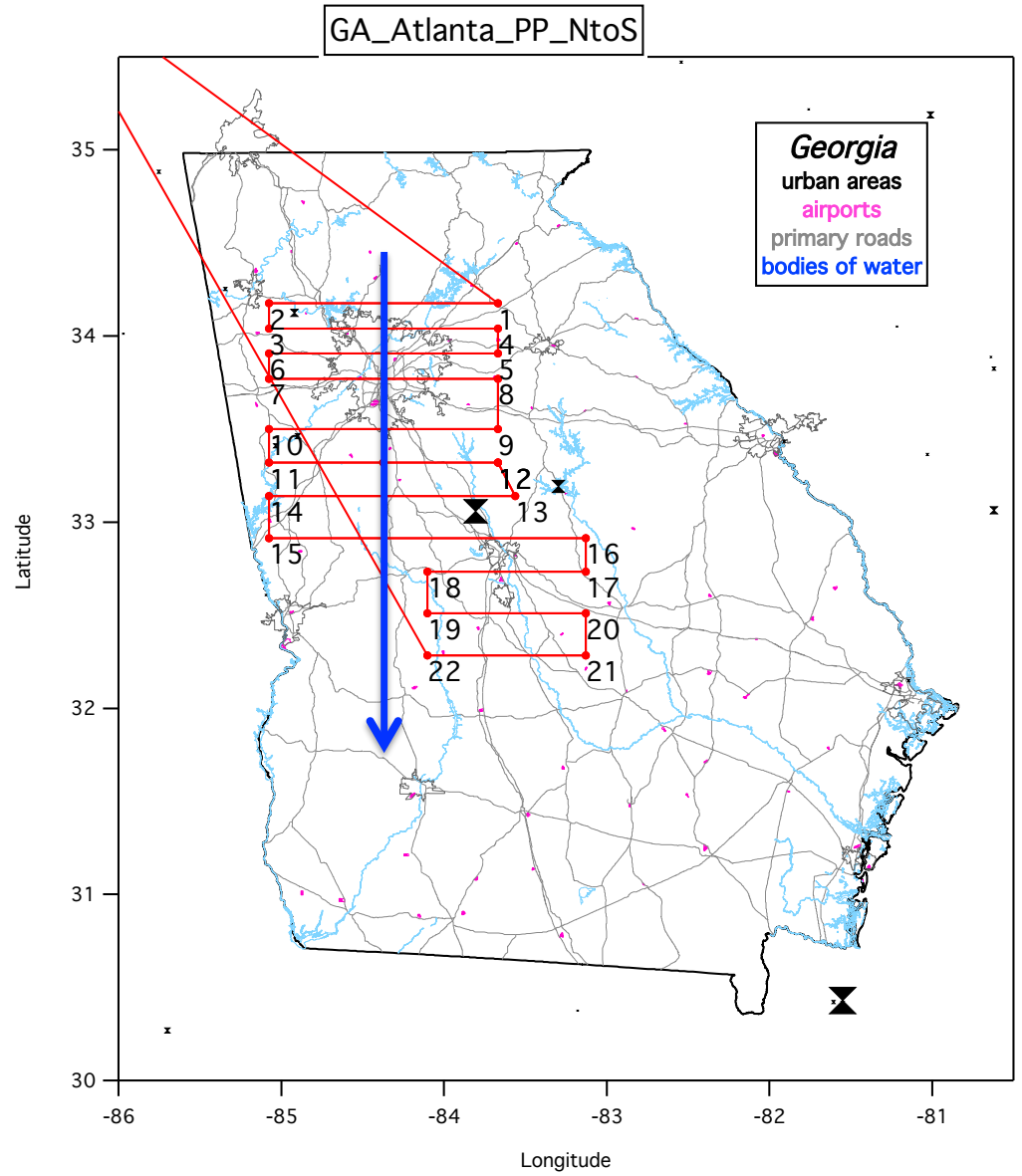
Operated out of Smyrna regional airport
110 flight hours, June 3 – July 15



Operator seats:
NO_2O_5: C3X
CRDS: Sta. 2
AMS: Sta. 3
CIMS: Galley
rotating: Galley

Non CSD collaborators
CCN: Nenes
HCHO: Hanisco/Keutsch
Acid CIMS: Thornton

Flight Plans: O_3-SOA Formation in Clear Air

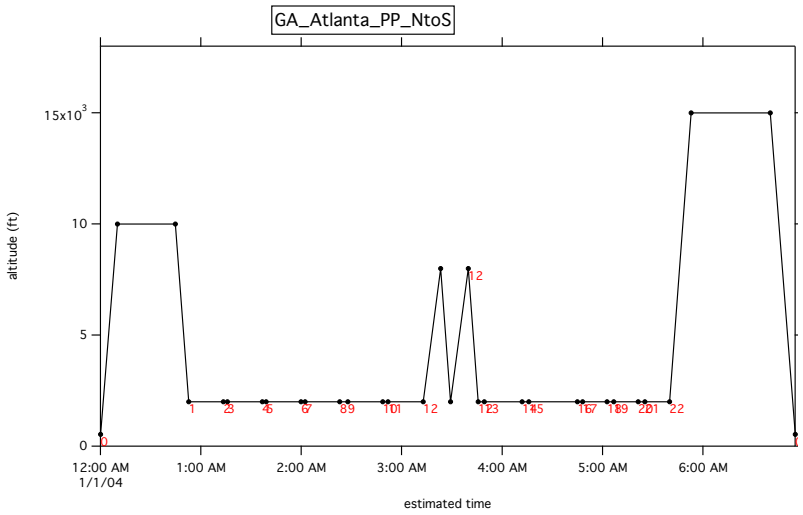


Oxidants & aerosol formation in:

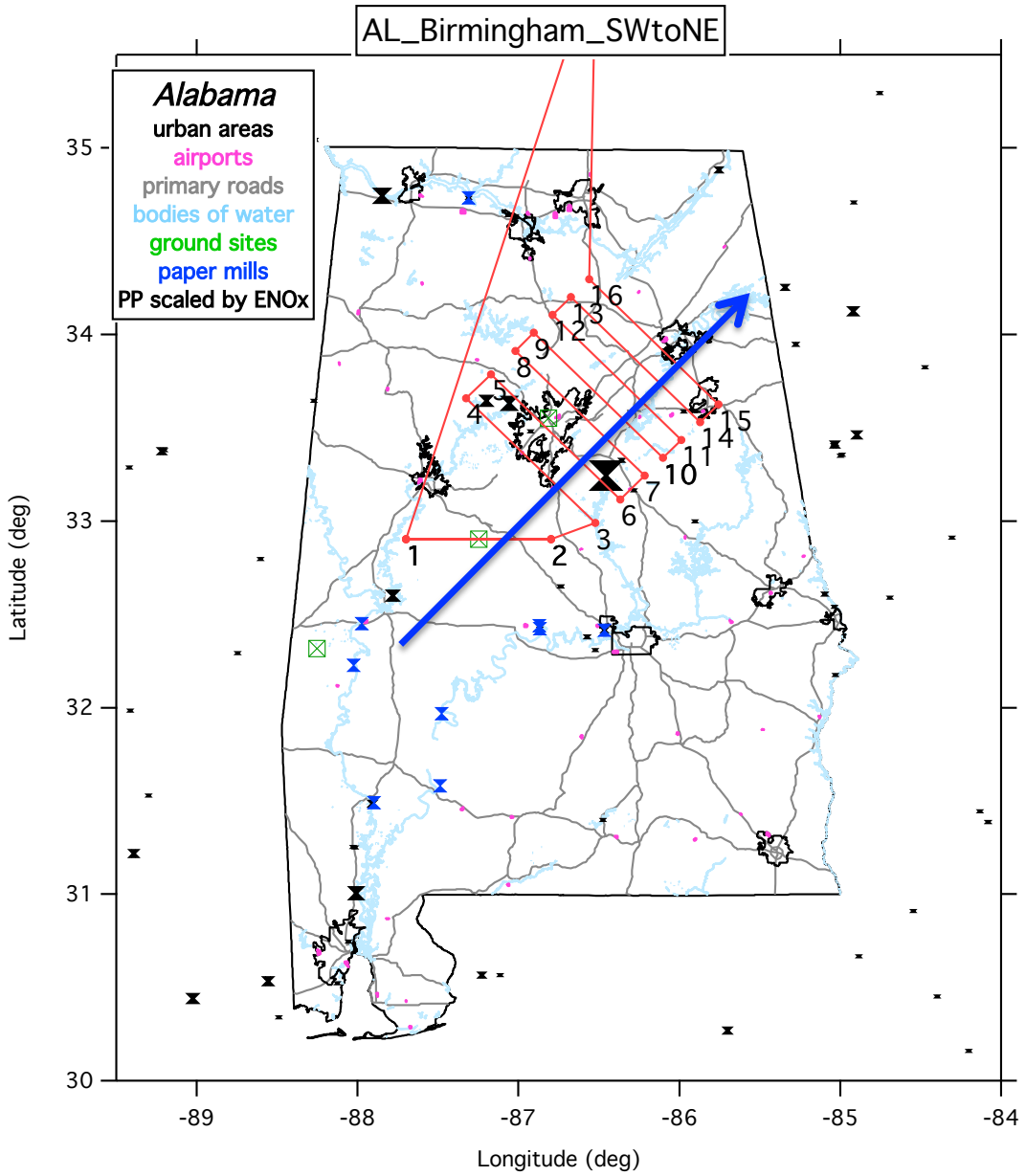
- Urban plumes: NOx, SO_2, POA, BC and anthropogenic VOCs
- Power plant plumes: NOx, SO_2, no POA, no anthropogenic VOCs

With high and low biogenic VOCs

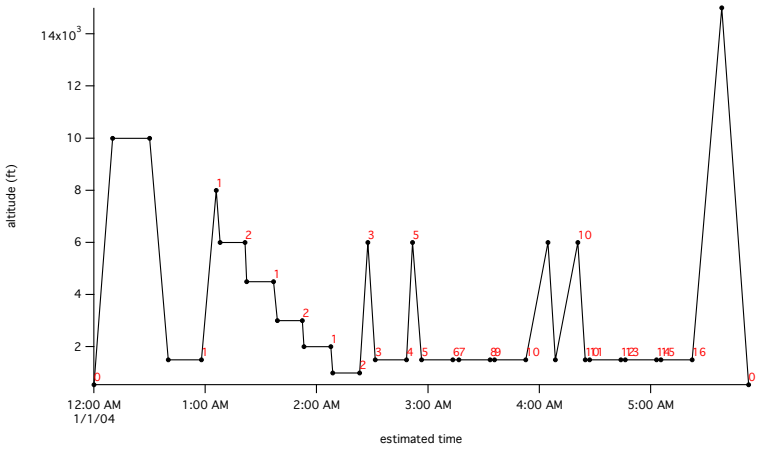
Cities: Atlanta, St. Louis, Nashville, Birmingham, Indianapolis



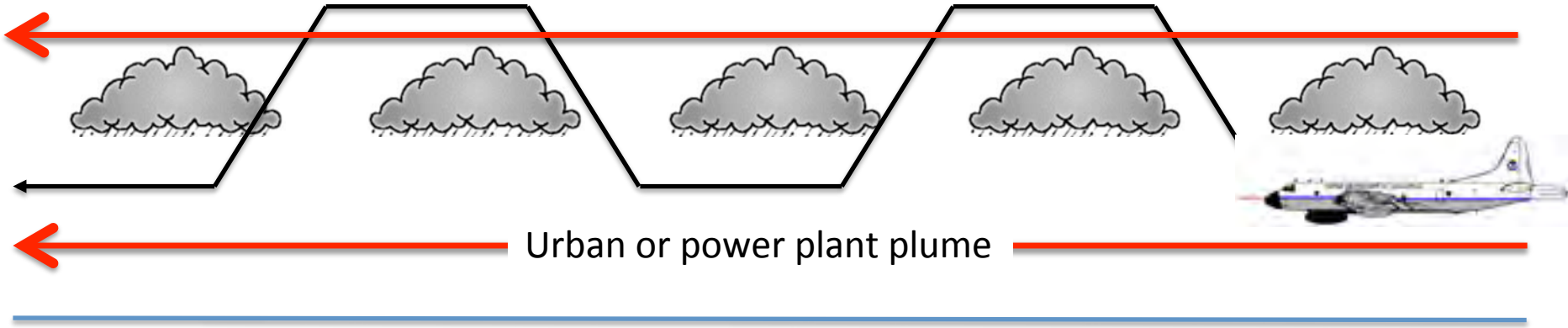
Flight Plans: O_3-SOA Formation in Clear Air



Example of a Birmingham flight including overpass of the Centreville site



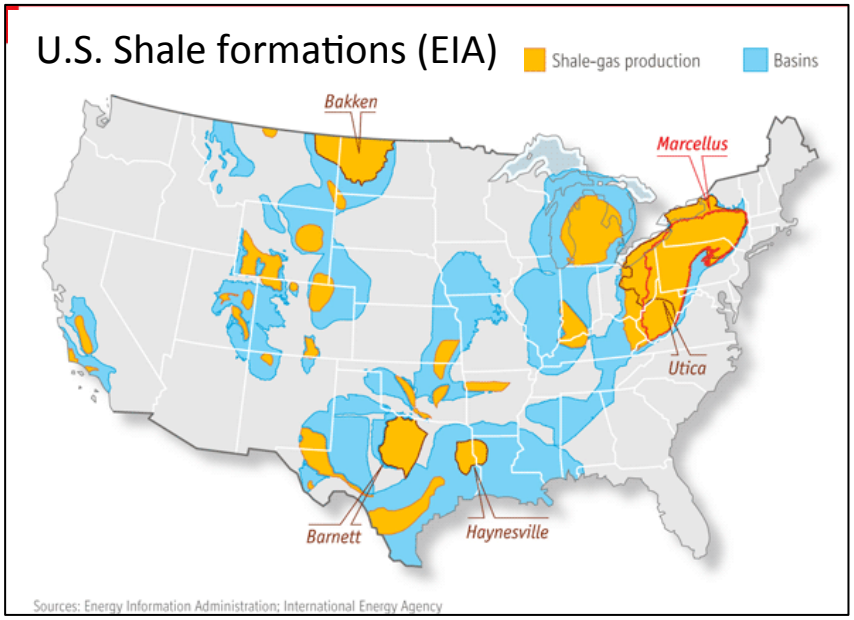
Flight Plans: SOA & Sulfate Formation in Clouds

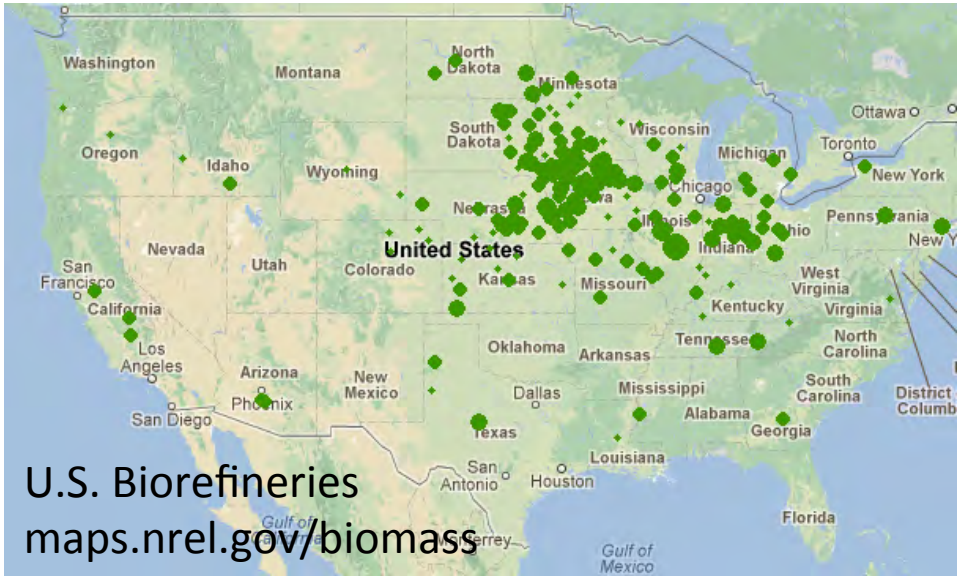


- Compare chemical evolution of plume above and below clouds
- Identify and quantify cloud-modified formation of sulfate, organics, others above cloud
- Successfully done during 1 flight in TexAQS 2006; will be looking for opportunities during SENEX

Flight Plans: Other Goals

1. Nighttime chemistry and SOA formation
2. Regular overpasses of Centreville site
3. Inter-comparison flights with C-130
4. Emissions from natural gas production in Haynesville Shale
5. Emissions from biofuel refineries (Archer Daniels Midland, Decatur, IL)





SENEX as Part of the Southeast Atmosphere Study

Four aircraft:

1.	NOAA WP-3D	Smyrna, TN	June 3 – July 15	
2.	NCAR C-130	Smyrna, TN	June 1 – July 15	
	NAAMEX	Mercury	Jaffe	NOMADSS
	SOAS	Biogenic VOCs	Guenther	NOMADSS
	TROPHONO	HONO	Zhou, Stutz	NOMADSS
3.	Duchess	Tuscaloosa, AL	Shepson	
4.	Long-EZ	Tuscaloosa, AL	Mak	

Four ground sites (SOAS):

1.	CTR SEARCH site, AL	Carlton, Goldstein, Jimenez
2.	AABC flux site, AL	Guenther
3.	Look Rock, TN	Surratt
4.	RTP, NC	Offenberg

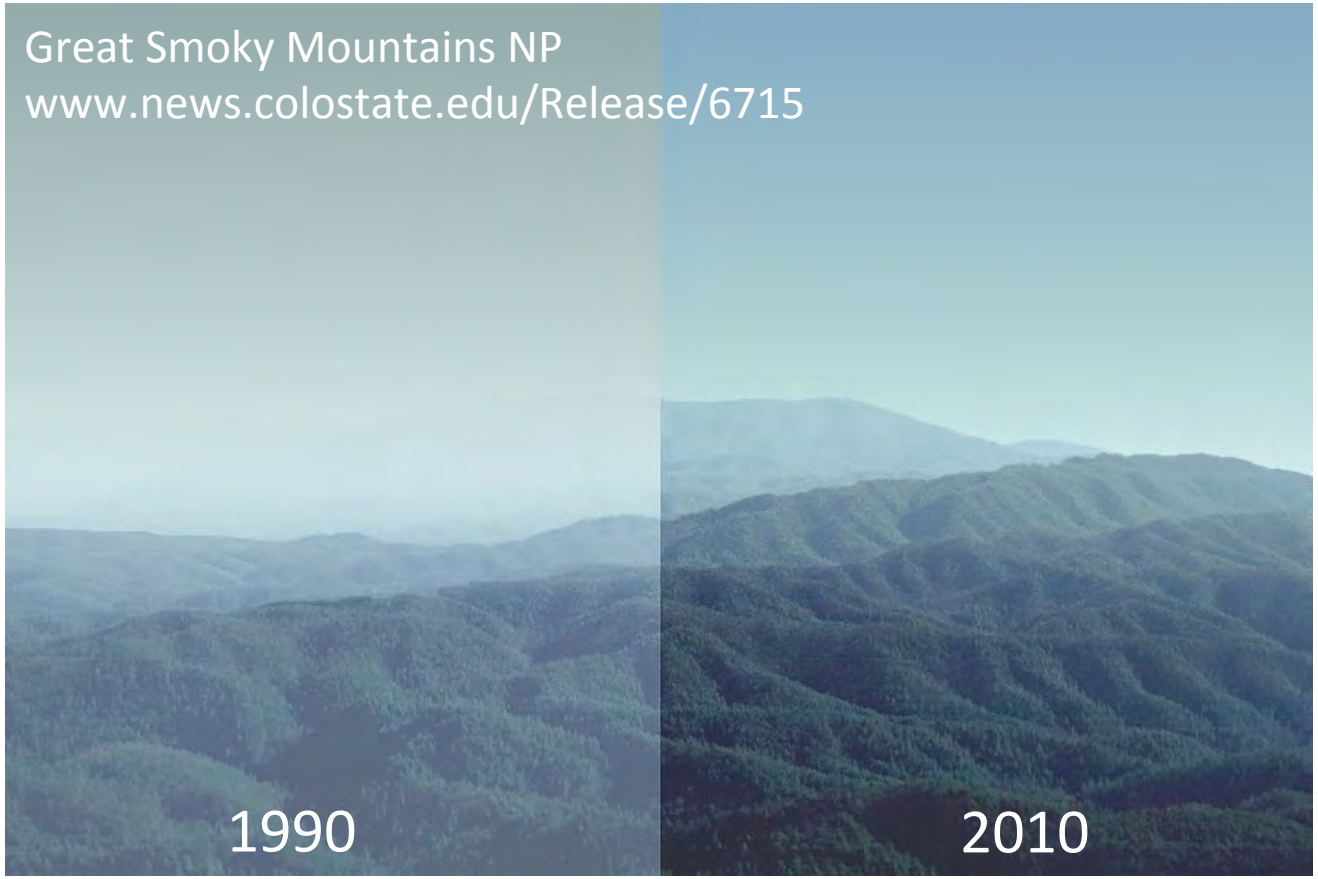
Southeast Atmosphere Study (SAS) 2013

Synergies between SAS and SEAC^{4}RS

1. Extend measurements in the Southeast into August-September
2. Collaboration on modeling
3. Characterization of deeper convective outflow by DC-8
4. SEARCH sites will still be up: extend with AERONET stations and balloon sondes for SAS?

Questions?

Southeast Nexus (SENEX)



- Biogenic emissions in the Southeast are thought to be important precursors for organic aerosol formation
- PM2.5 in the Southeast has strongly decreased (including organics)
- What fraction of organic aerosol is controllable?